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ABSTRACT

The paper describes concepts and principles resulting in successful applications of computer technology to the needs of the disabled. The first part describes what a microcomputer is and is not, emphasizing the microcomputer as a machine that simply carries out instructions, the role of programming, and the use of prepared application programs. The second part examines three roles for the computer in the communication rehabilitation of the disabled: (1) temporary use of a computer for assessment, education, therapy, or training; (2) long-term use of a computer as a personal aid (usually of a prosthetic nature); and (3) use of the same computers running the same programs as everyone else. The effective use of computers as personal communication aids is stressed, with particular emphasis on the importance of portability, the computer as a component of a communication system, and the computer's role in writing. Among the possible future trends identified are technical advances (such as headpointing, eyegaze and voice input) and social advances (such as more successful competitive employment by disabled individuals and better information and service delivery). (DB)

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COMPUTERS AS AUGMENTATIVE COMMUNICATION SYSTEMS

Gregg C. Vanderheiden, Ph.D.

We have just finished two days of marvelous examples of the ways in which we can use technology for disabled persons, and the ways in which disabled persons can use to technology themselves to advance their abilities and opportunities. This morning, I would like to focus not on additional examples of these technologies, but rather on some of the underlying concepts and principles that separate the successful applications of technology from the many failures. We have shown many applications here. The ones that we show you, of course, are, for the most part, the successful ones. We also have a very large number of placements that did not work out; where we had to go around two or three times before we actually found something that would in fact work. This morning, therefore, we will be focusing on getting a better understanding of the microcomputer and how can be applied to successfully meet needs of communicatively disabled individuals.

My talk will be broken into three parts. First I will be focusing on the microcomputer in order to create a better understanding of what it is and what it is not. We hear a lot about this creature, but interestingly, we find that most people have a very poor understanding of what it is, and what it can and cannot do. As a result, many computers are purchased with very high expectations that are never fulfilled. A good understanding of the computer is essential to any successful application of it.

The second part of my talk will be focusing on the role of microcomputers in communication rehabilitation. We will be discussing the various needs of disabled individuals in this area, as well as the potential and limitations of current microcomputers in meeting these needs.

Finally, I will be looking at future directions. This will look not only at advances in technology, but also at where we will be going in research and our delivery systems.

PART I: UNDERSTANDING MICROCOMPUTERS

In a computer workshop series I teach, I always start off by asking people what a microcomputer is. The answers I get are very interesting. Some people respond that it is a thinking machine; but the fact is that microcomputers don't think at all. Others will say that it is a word processor; some will suggest that it adds and subtracts numbers. In reality, the microcomputer itself is a very, very simple device... a device that can only

do one thing. **A microcomputer is really nothing more than a machine that carries out instructions.**

Microcomputers do not add, subtract, multiply, or divide. They cannot think. They cannot process. They cannot solve problems. All they do is follow instructions.

If you tell a computer to print "4" when someone types in "2+2=" and then someone types in "2+2=" it will print "4." Did the computer add 2 + 2? No, the computer just followed instructions. If you told the computer to print "5" when someone typed in "2+2=" and then someone types in "2+2=" then the computer will print "5." Did the computer make a mistake? No. Again, it simply followed instructions.

The question then arises: If computers are so stupid, and can only do just what we tell them to do, what good are they? Microcomputers are useful to us because they have an excellent memory, are extremely fast, and are incredibly precise. Computers can carry out instructions at the rate of a million instructions per second. They are absolutely precise in carrying out the instructions; they have an excellent memory; and, because they are dumb and only follow instructions, they carry out these instructions exactly as they are written. In fact, when you have something carrying out instructions at the rate of a million per second, you really don't want a device that is anything but extremely precise, and that follows instructions exactly. Imagine a device that either made a mistake or deviated from instructions once every ten million instructions. How long would it operate, at a million instructions per second, before it got off track or crashed? That's right; ten seconds.

So, what we have is a device that can carry out instructions extremely quickly and extremely accurately. What can we do with such a device? We can do anything for which we can create a precise set of instructions. This set of instructions for the computer is called a computer program. Computer programmers are simply people who are familiar with the instructions that a computer will understand, and who can write sets of instructions for the computer. One set of instructions (one program) may be a set of instructions that will cause the computer to behave like a word processor. Another set of instructions (another program) may cause the computer to behave like a video game. Still another set of instructions may cause the computer to act like a chess master. In all three cases, the computer has no idea what it is doing; it is simply executing the instructions it has been given. If you are playing chess with a computer, you are not actually playing against the computer itself; rather, you are playing chess against the computer program, or against the list of instructions that some programmer has put into the computer. In fact, you could take the computer away and have a

human being who knows nothing about chess follow the exact same instructions and he would play the same game as the computer would. The difference would be that the computer could carry out the instructions at one million per second, and would never make a mistake in following the instructions.

WHO ARE COMPUTER PROGRAMMERS?

As we stated earlier, a programmer is anyone who creates a program. A program is simply a list of instructions. Every one in this room has at one time or another written a list of instructions for some other person to carry out. That makes each and every one of you a programmer. The difference between you and a computer programmer is simply that a computer programmer knows how to write a list of instructions (program) for a computer.

If you had a Czechoslovakian gardener, you would probably have difficulty in writing a set of instructions for him until you learned Czechoslovakian. Similarly, the only thing you need in order to be a computer programmer is to understand what the instructions are that a computer will understand. In our computer workshop, we have all the participants writing simple computer programs within a span of two hours, even those participants who were afraid to touch the keyboard at the beginning of the session.

Programming a computer, however, is something like playing the piano. Anybody can learn to play the piano. However, to play the piano well (or to program computers well), you need to invest a lot of time in practice. Also, there are some individuals who have a knack or talent for it, and who can learn to play the piano with much less effort and much greater skill than others. In fact, what comes out often sounds somewhat magical. Similarly, there are people with talents and abilities in computer programming that allow them to write programs that also seem somewhat magical. There is, of course, nothing magical about the computer itself, nor the act of writing instructions that it will meticulously carry out. However, it is sometimes hard to remember this when we look at the results of some of these individuals' efforts.

WHAT CAN A COMPUTER DO?

No matter how magical it all seems, however, it is important to always remember that every thing a computer does is completely the result of the instructions it has been given. If it appears to make any mistakes, it is because the instructions it has been given have a flaw in them (also referred to as a "bug" in the program).

If you don't like the way the computer is behaving, it is not the computer that is at fault, but the set of instructions that were given to it. If it is a program designed to be used by you as a clinician or disabled individual, and you do not like the way it

operates, then you should not be satisfied with it, but complain to the program's authors. The next time they write a program to accomplish this, they may write the instructions so that the computer/program will act or function in the fashion which better meets your needs.

The bottom line is that computers behave exactly as they are instructed to behave (unless they are broken, in which case they generally don't do anything at all). What computers can do is limited only by two things:

1) the ability of humans to write a set of instructions to carry out a task (that is, the computer can't do anything that somebody can't write a set of instructions for it to follow),

and

2) what the computer is physically capable of doing (for example, a computer cannot be instructed to print a letter if it has no printer attached, nor it can be given instructions that will cause it to make a beep if there is no speaker attached or included as part of the computer).

For the most part, the potential of computers in meeting our needs in the area of communication rehabilitation is therefore limited only by our ability to define exactly, precisely what we would like the computer to do and to develop a set of explicit instructions in the computer's language to carry out these functions.

Of course, we do not have to become involved in programming a computer at all in order to use the computer. If programs already exist that meet our needs, we can simply buy these programs, load them into a computer, and run them. It is not necessary to understand how to program a computer in order to use one any more than it is necessary to understand how to write music in order to enjoy listening to it, or understand how a car works or be able to repair a car in order to use one. It turns out that 98% of the people who use computers do not know how to program them or to do anything other than run the programs that they need on the computer. The secret in using a computer effectively is finding sets of instructions (programs) that meet your needs. This should be done before you consider buying a computer since it may affect what computer you buy. If there are no programs that currently meet your needs, then you have no use for a computer other than as an expensive paperweight.

PART II: COMPUTERS IN COMMUNICATION REHABILITATION

There are three distinct roles that computers play in the lives of disabled individuals. Each of these roles is quite different. As a result, the type of computer that might be chosen for each of the roles may also be quite different. In studying the different

applications for disabled individuals, it is quite useful to bear in mind the three roles and their different constraints. The three roles are:

1) temporary use of a computer for assessment, education, therapy, or training (the computer is usually owned by someone else, and usually can be stationary);

2) long-term use of a computer as a personal aid (the computer is owned by the disabled individual, and often must be portable);

3) use of the same computers running the same programs as everyone else (these are the same computers that non-disabled people encounter and must use in their educational programs, jobs, and, soon, the community).

Most of the programs currently available in the rehabilitation field fall into the first category. This includes all of the special education, therapy, and assessment programs, etc. The computers are generally owned by a hospital, school, or rehabilitation center. The disabled individual uses them temporarily in order to develop or strengthen some skill.

The second category encompasses all of the applications of the computer where it serves as a personal aid for a disabled individual. In this case, the user would normally have to own the computer so that it is always available, in the same way that a wheelchair is always available. Examples of the use of the computer as a personal aid include: communication aids for individuals who cannot speak; writing systems for individuals who cannot physically write; braille-to-text and text-to-braille translators for blind individuals, etc. Because of the prosthetic nature of these aids, they usually need to be quite portable in order to move about with the individual at home, in school, and at work.

The third category is a very important but often overlooked category. It is the access by disabled individuals to all of the computers that will soon be in widespread use in our society. Computers are very quickly working their way into our employment and educational settings. Within ten years, it may be impossible to take most educational courses without having some portion of the course taught on computers, or tested using computer-based tests. Independent assignments may require the use of the computers, and many experiments will be conducted via computer simulation. When this occurs, it will not be possible for anyone to participate in regular education programs unless they are able to use those computers. Currently, many cognitively alert but physically handicapped individuals are unable to use the computers that will be integral to the

classroom settings. The problem is even more acute in the employment area; the number of non-manual labor jobs that do not involve the use of computers is dwindling rapidly. The incorporation of computers in the job site could be a tremendous boon to individuals with physical and sensory handicaps. If, however, an individual is unable to use these standard computers as they are set up in the job sites, then these individuals will find a smaller and smaller number of jobs open to them. In fact, individuals currently holding jobs may find that they are unable to hold them after computers are incorporated into the job. Mechanisms need to be provided to allow individuals with handicaps to access and use standard computers running the standard software programs so that they will be able to participate alongside of their able-bodied peers.

PERSONAL COMMUNICATION AIDS

Let's take a look at the use of computers as personal communication aids. Please note that this can include both categories 2 and 3. A well-designed communication aid will also include mechanisms for allowing the individual to access and use other, standard computers in his environment.

In looking at computers as communication aids, there are many factors to consider, most of which have been touched on in the other presentations of the last few days. There are, however, three basic areas I would like to highlight. They are:

1) the need for portability;

2) the need to look at the computer as one component in an individual's overall communication system;

3) the importance of writing as a communication need.

The Importance of Portability

Portability must be considered one of the primary criteria. If a computer is to function as an individual's communication prosthesis and primary means of communication, then it must be able to stay with him and be usable by him at all or almost all times. The use of stationary computers that plug into the wall as communication prostheses is of only limited value. I would like to posit that a communication aid that plugs into the wall is about as functional as an artificial leg that plugs into the wall. It's not that such an artificial leg is not useful; I could have given the entire presentation this morning with one. However, something as important as an individual's leg or his voice needs to be more portable than the length of an extension cord.

In the past, we had very few options in the way of portability. Today, however, there is a growing number of portable, battery-operated computers. A number of

manufacturers are taking these portable computers, writing special programs for them, and marketing them as very powerful portable communication aids. Even if these computers do not run a wide variety of software, they can function as very powerful single-function communication aids. In fact, for computers functioning in Role 2, it is not necessary that they run a wide variety of different programs. This is actually a feature we look for in computers that are operating either in Role 1 or in Role 3.

The Computer as a Component of a Communication System

When computers are used as the basis for a communication aid, they can provide us with a very powerful new tool. However, they cannot and will not be able to meet all of the individual's communication needs. There are some types of basic communication that are often best done without any technical aids. For example, a single gesture, facial expression, etc., may be much quicker and more effective than resorting to a longer process using the communication aid. The individual's remaining speech capabilities should also be capitalized upon. Whenever an individual's residual speech is understandable, it is generally faster, more flexible, and more powerful than other forms of communication. Often an individual will have some words or phrases that are understandable to close friends or family. In these instances, they should be encouraged to use their speech whenever possible. Thus, we should think of an individual's communication system as including his residual speech skills, facial expressions, gestures, standard or special signs and signals, as well as any high- or low-technology communication aids.

Writing

Finally, I would like to highlight the importance of writing as a communication need. We so often focus on the fact that our clients cannot speak that we forget the fact that they also cannot write. In fact, we have many clients who can speak fine, but do not have any effective mechanism for writing. Further, writing is a critical need for education, self-development, and eventual employment. Imagine sending any of your children to school but telling them not to worry about taking pencil and paper -- that they needn't worry about doing homework but just listen to the teacher and learn that way. Imagine trying to learn math without a pencil and paper. In fact, most of us, even after having all of our educational skills acquired, would find it extremely difficult to even get our thoughts together (e.g., preparing for a speech) without using a pencil and paper. Yet there is a very large number of physically handicapped individuals who cannot write, and who are not provided with any alternate method for writing, but are placed in our educational system. We must begin to recognize that provision of an

effective mechanism for writing is critical to their ability to participate and receive an adequate education.

PART III: THE FUTURE

As we look to the future, what will we see? We are going to see more powerful and more portable microcomputers. These microcomputers will be able to hold larger sets of instructions (programs), and carry them out faster. As a result, we will be able to write more flexible programs, store larger vocabularies, and do so in a smaller package.

We will also be seeing newer and more efficient interfaces to computers. Headpointing, eyegaze and voice input are three exciting areas where we will be seeing progress over the next 5 to 10 years.

Advancing technology will not be the most exciting advance we will see, though. I think that the most meaningful advances will occur in basic areas.

We can expect in the future that there will be more examples of successful competitive employment by disabled individuals. Already we have severely physically handicapped individuals in open competitive employment, working in private industry and managing well. As society gets more and more automated, it will be easier and easier to make these kinds of placements. In addition, the ability to work from our homes may provide some more severely physically handicapped individuals with the ability to work where transportation and daily care needs might otherwise prohibit employment.

One of the areas of greatest advance, if we are going to really meet the needs of disabled individuals, will have to be in our information and service delivery areas. At the present time, only a small fraction of what we know is being practiced clinically on a widespread basis. This is largely due to a lack of good information dissemination and the need for better application information and materials. I think that the greatest need for disabled people at the present time is not newer technologies, but newer and better delivery of technologies. It is in these areas that I expect we will have our greatest impact on the lives of persons with disabilities.